IDENTIFICATION OF BURIED OBJECT BY USING THE HVSR METHOD

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Abstract- In order to identify a buried object in a sediment; a solid concrete cylinder of 1 m long and 30 cm in diameter was buried at a depth of 1 m and oriented north-south with 450inclination. This cylinder was used for modeling purposes. The next part was installing a square array of 13-point geophones with a two-meter aperture. Measurement points were separated 1 m from each other. One central measurement point is located just above the buried object for the measurement of background vibration. Measurements were made with a 100 Hz frequency count. Subsequent comparison of horizontal and vertical spectra was carried out using the Konno-Ohmachi smoothing method with 40 smoothing constant and 5% cosine sharpening, and also STA/LTA values that range from 0.2-2.5. Based on the spectra profile of HVSR amplitude for each line, it is inferred that the HVSR peak frequency correlates well with the buried object in the sediment. The highest HVSR amplitude was obtained on the spot just above the buried object.
Keywords: HVSR, frequency, peak, amplitude spectra

1. INTRODUCTION

HVSR (Horizontal to Vertical Spectral Ratio) is a comparison between horizontal Fourier spectrum against its vertical counterpart of the ambient vibration (ambient noise). It was first introduced in the early 1970s by Japanese scientists Nogoshi and Igarashi (1971) and also Nakamura (1989). Nowadays, HSVR has been widely used in studying the effects of local geological effects of ground motion due to earthquake that is commonly referred as site effects (Theodulidis, 1996; Bard, 1997; Chavez et al., 2000, Scherbaumet al., 2003). Site amplification that depends on frequency is dominantly known as caused by reverberation and the effects of S wave resonance within unconsolidated documents located on top of stiffer formations which are related to variations in incoming wave intensity. Local geology may modify the characteristics of incoming seismic waves, resulting in either amplification or attenuation. Parolai et al. (2001) states that the deeper the bed rock, the less the resonance frequency is, and vice versa. Based on those facts, this research aims to measure HSVR of a site sediment layer with buried objects underneath it and determines certain measurement configurations to figure out the correlation of HVSR peak frequencies of objects buried in a sediment. The results are expected to be one of the tools to measure or find objects or bodies underneath certain sediments. These may include ancient temples buried in deep sedimentation that result from settling cold lava.

2. RESEARCH METHOD

In this research a solid concrete cylinder of 1 m long and 30 cm in diameter was buried at a depth of 1 m and oriented north-south with 450inclination. Its coordinates are 07o02'56.2" and 110o26'27.5". Right on top of the object is measurement point center (point A). Next, a square array of Data mark LS-800WD seismometers is set which is comprised of 13 points. The aperture is two meters, and each measuring point is one meter apart. A background vibration measurement then ensues. Measurements using this array are not carried out for all point at once, but in sequence from one point to the next using a seismometer. Figure 1 depicts the configuration and the position of the buried object. Sampling is carried out at 100 Hz frequency and each measurement lasts for 5 minutes. In the subsequent data processing, comparison of the horizontal spectra and their vertical counterparts is made with the help of the Konno-Ohmachi smoothing method at smoothing constant of 40 and 5% cosine sharpening with one second STA 1 and 30 seconds LTA and also STA/LTA values of 0.2-2.5. Analysis is done by plotting the HVSR spectra on the measurement lines. Data processing and analysis is conducted using Geopsy 2.9.0 software.

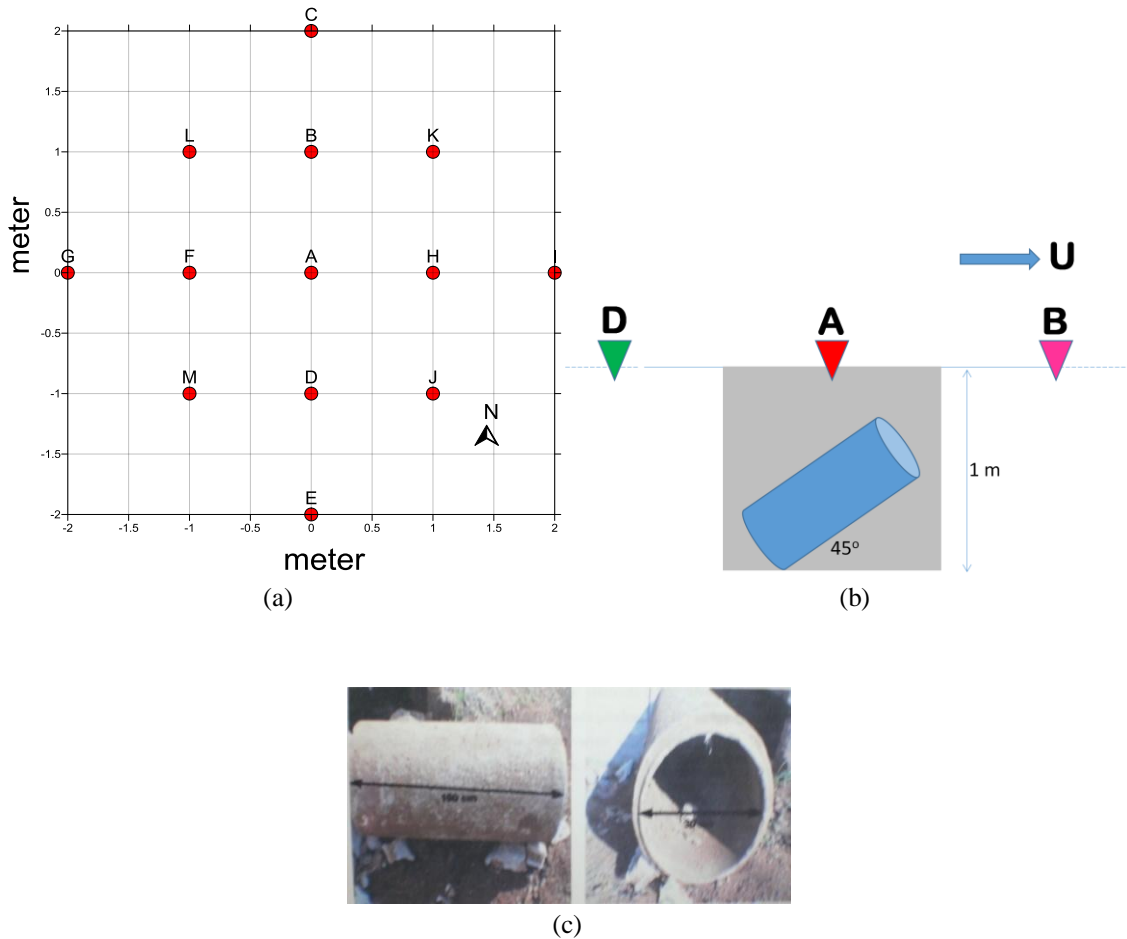[1,2,3] Physics Department, Diponegoro University, Semarang, Central Java Indonesia

(a)

(b)

(c)

Figure 1 (a) Measurement point configuration; 1 m space and 2 m aperture, (b) position of the buried object; A, B, andD are seismometer positions;the object isinclined 45oagainst the North (c) the concrete cylinder buried in the sediment

3. RESULT AND DISCUSSION

Processing results in the form of HVSR curves for each measurement point for the buried object are given in Figure 2. Point measurement A yields the highest HVSR amplitude at 2.569, whereas the other measurement points have HVSR amplitudes that range from 1.156 to 1.903. Recorded frequencies for each measurement point are in the range of micro seismic frequency (below 1 Hz). Only two points come with signals from anthropogenic sources; they are point B (38.115 Hz) and point I (45.878 Hz).
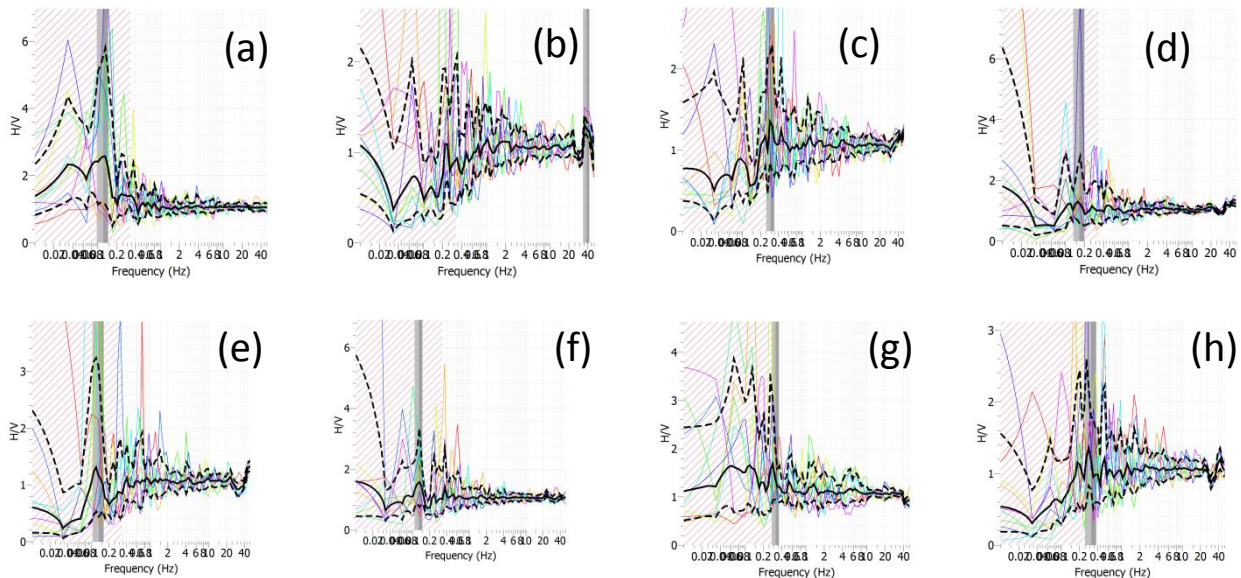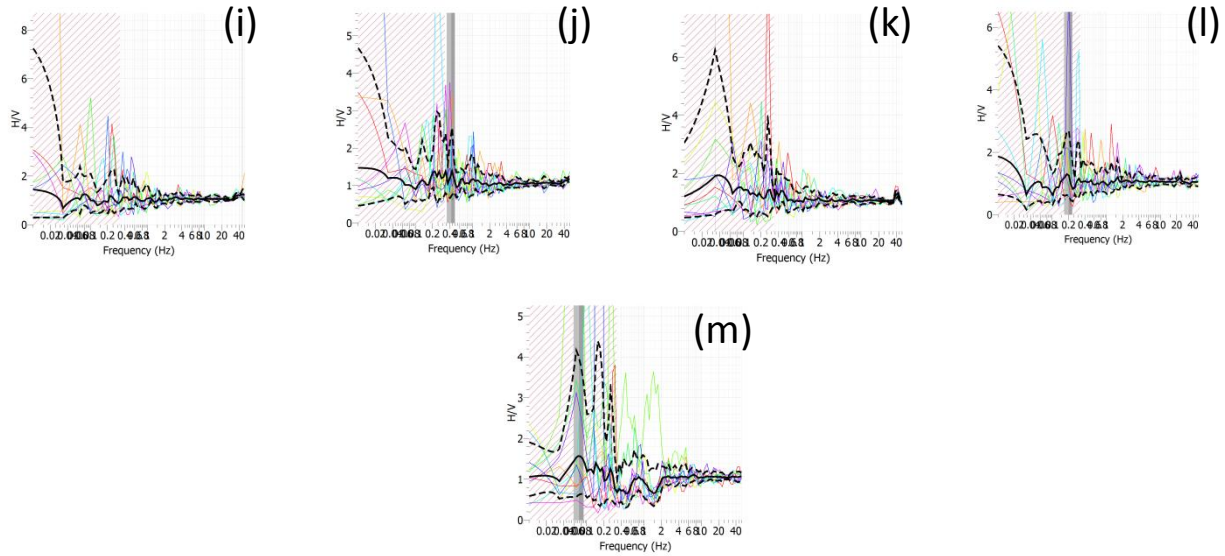
Figure2HVSR curves for each measurement points

Profiles of HVSR amplitude spectra from measurement lines are given in Figure 3. The lines crossing point A (CBADE, GFAHI, KAM, and JAL) come with clear HVSR amplitude spectra profiles at their centers with peak frequencies ranging from 0.01 Hz to 0.15 Hz. On the other hand, the lines that do not cross point A (LBK, JDM, LFM, and KHJ) do not yield the same peak frequency patterns.
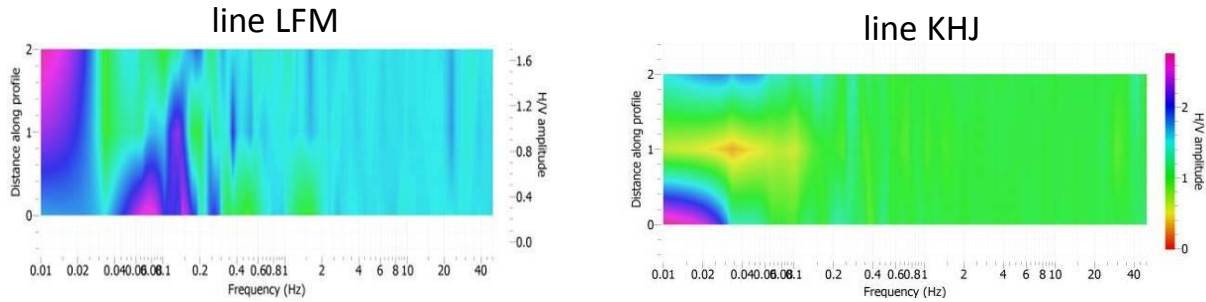
line LFM   line KHJ
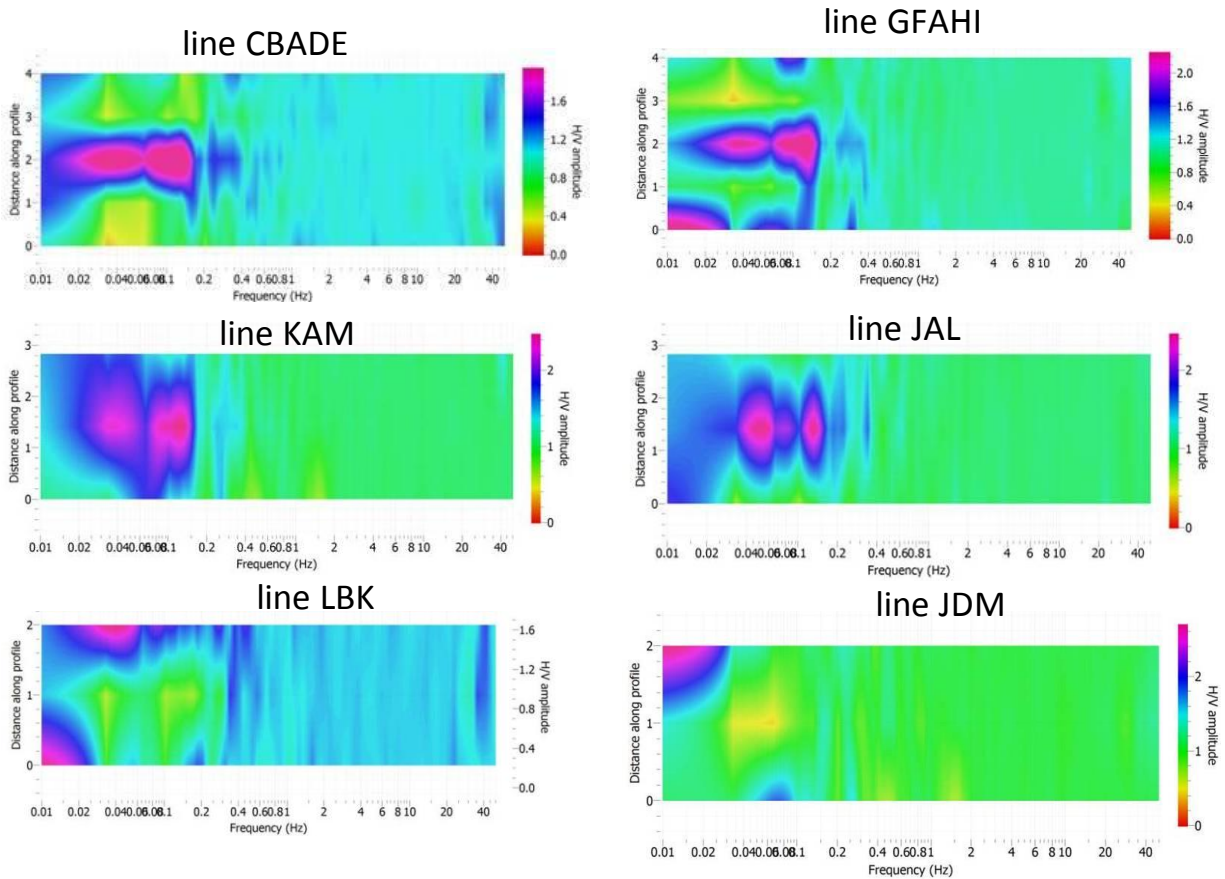
Figure3Profiles of HVSR amplitude spectra for each measurement line

For line CBADE, as it has the same axis as the buried object, it has wider peak frequency compared to line GFAHI that crosses the cylinder.For lines KAM and JAL, as they cross the cylinder length at a 45o angle, it has a wider line profile compared to the up straight line (CBADE) and the crossing line (GFAHI). This is because the buried object (concrete cylinder) acts like bedrock that reverberates large amount vibration energy to the sediment above it. For line CBADE, on its northern point (shallower object position), the amplitude and frequency it has is relatively higher compared to its southern point (deeper object position).

4. CONCLUSION
Based on the HVSR amplitude spectra for all lines, it can be concluded that HVSR peak frequency well correlates with the buried object in the sediment. The highest HVSR amplitude is observed at the point directly above the buried object.

5. ACKNOWLEDGEMENT

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